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Logistic support for non-developmental Items

Weaver, Steven E.

Monterey, California. Naval Postgraduate School

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Non Developmental Items

by

Steven E. Weaver

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In formulating the model presented in this thesis (the Support System Decision Matrix), actual cases of NDI were studied and; the lessons learned from these efforts were consolidated into a model. The heuristic considers system use factors and system specific factors and ranks the four basic ways to support a system: (1) discard system upon failure (no support), (2) total contractor support, (3) organic support and (4) a combination of organic and contractor support.

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Logistic Support
for
Non-Developmental Items

by

Steven E. Weaver
Lieutenant, United States Navy
B.S., U.S. Naval Academy

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Author: [redacted]
Steven E. Weaver

Approved by: [redacted]
Edwin N. Hart, Thesis Advisor

[redacted]
Dan Trietsch, Second Reader

[redacted]
David R. Whipple, Chairman
Department of Administrative Sciences

[redacted]
Kneale T. Marshall,
Dean of Information and Policy Sciences

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TABLE OF CONTENTS

I. INTRODUCTION 1

A. BACKGROUND 1

B. OBJECTIVES 1

C. RESEARCH QUESTIONS 1

D. SCOPE, LIMITATIONS AND ASSUMPTIONS 2

E. LITERATURE REVIEW AND METHODOLOGY 2

F. DEFINITIONS AND ABBREVIATIONS 2

G. ORGANIZATION OF THE STUDY 3

II. FRAMEWORK AND BACKGROUND 4

A. INTRODUCTION 4

B. THE ACQUISITION PROCESS 4

C. DEFINITION OF NDI 8

D. MILESTONE PROCESS 9

E. CONCEPT PROVE-OUT PHASE 17

F. PRODUCTION AND DEPLOYMENT 18

G. CHAPTER SUMMARY 19

III. RESEARCH QUESTIONS 20

A. NON-DEVELOPMENTAL ITEM DEFINITION 20

B. HOW IS THE DECISION MADE TO USE NDI IN MEETING A MISSION NEED? 21

C. WHAT SPECIAL SUPPORT CONSIDERATIONS ARE NECESSARY FOR NDI? 31

D. WHAT PROGRAM PARAMETERS ARE BEST INDICATORS FOR CHOOSING A SUPPORT PROGRAM? 32

E. CHAPTER SUMMARY 36

IV. THE SUPPORT SYSTEM DECISION MODEL 38

A. INTRODUCTION 38

B. METHODS OF SUPPORTING NDI SYSTEMS 40

C. VARIABLES AFFECTING THE LOGISTIC SUPPORT DECISION 48

D. THE MODEL 49

E. DISCUSSION OF THE MODEL'S WEIGHTINGS 50

F. CHAPTER SUMMARY 53

V. CASE STUDY 56

A. LOGISTIC APPLICATIONS OF AUTOMATED MARKING AND READING SYMBOLS (LOGMARS) 56

B. SUMMARY 62

VI CONCLUSIONS AND RECOMMENDATIONS 68

A. CONCLUSIONS 68

B. RECOMMENDATIONS 70

C. AREAS FOR FURTHER STUDY 71

APPENDIX A 74

APPENDIX B 75

APPENDIX C 79

LIST OF REFERENCES 82

BIBLIOGRAPHY 83

INITIAL DISTRIBUTION LIST 85

I. INTRODUCTION

A. BACKGROUND

This thesis examines logistic support concepts for Non-Developmental Items (NDIs). It analyzes the way to develop a logistic support strategy for NDIs. The research focuses on how system use factors and other program characteristics will affect the support decisions.

B. OBJECTIVES

The objectives of this study are: (1) to determine how program managers choose an NDI to meet an operational requirement, (2) to identify the causes for logistic support difficulties when fielding NDIs, (3) to identify the program parameters that can suggest the most effective support program, and (4) to develop a model to aid in determining the preferred method of support for an NDI.

C. RESEARCH QUESTIONS

In pursuing the objectives of the research, the following questions were addressed:

1. How is the decision made to use an NDI to meet an operational requirement?
2. What method best determines how to support an NDI?
3. What program parameters identify the best support program?
4. Is it possible to develop a model which will aid the program manager in determining which support method is best suited for the acquisition?

D. SCOPE, LIMITATIONS AND ASSUMPTIONS

The scope of this thesis will cover the development of the heuristic, or rules of thumb, for choosing a satisfactory form of logistic support. This thesis will not define adequate logistic support, but will offer a way to rank alternative methods of providing logistic support based on a decision to use NDIs.

No factors limited the efforts of this research. This thesis focuses on the Federal acquisition process without specifically addressing the Planning, Programming and Budgeting System (PPBS). It is written under the assumption that the reader has a working knowledge of the requirements and procedures involved in the acquisition and budget process.

E. LITERATURE REVIEW AND METHODOLOGY

The information presented in this thesis came mostly from the available literature on the subject of system acquisition, logistic support and NDIs. The literature base includes current acquisition directives and instructions (specifically DOD instructions 5000.1 and 5000.2 of 1 September 1987 and OMB Circular A-109 of April 1976) and military department studies on acquisition and NDIs, and studies prepared by private companies such as the Logistics Management Institute. Finally, program managers and logisticians were interviewed for their personal insight of the subject.

F. DEFINITIONS AND ABBREVIATIONS

The concepts of this study are based on precise definitions used in acquisition management and logistics engineering. Appendix B is a glossary of terms and Appendix C is a list of acronyms used in this thesis.

G. ORGANIZATION OF THE STUDY

The organization of this thesis includes an introduction, four development chapters, and a final chapter of conclusions and recommendations. Chapter II provides an overview of the acquisition process and a background of NDI and related logistic support problems. Chapter III addresses the specific research questions and reviews the Department of Defense (DOD) guidance on NDIs and logistic support. Chapter IV presents a valuative model which can be used by a program manager as an aid in determining a support methodology for NDIs. This model emulates a model developed by LCDR D. S. Parry and LCDR B. R. Sellers for determining the "best method" of selecting a second-source contractor when the current item is provided by a sole source contractor. Chapter V is a case study of the Logistic Application of Automated Marking and Reading Symbols (LOGMARS) program. In addition, the model developed in Chapter IV is applied to the LOGMARS case study. Finally, Chapter VI presents conclusions drawn from this research and provides recommendations for further study. The appendices provide related information useful in improving the reader's understanding of the research.

II. FRAMEWORK AND BACKGROUND

A. INTRODUCTION

This chapter presents a theoretical framework for discussing acquisition and logistic support implications of Non-Developmental Items (NDI). It begins with a broad overview of the acquisition process; it considers the implications of NDI on the acquisition process and discusses some of the advantages and disadvantages of an NDI procurement compared to a non-NDI procurement.

The government acquisition process is very complex and cumbersome. Only through an understanding of this process and the nature of NDI's is a more specific examination of the support of these items possible. This chapter builds a foundation upon which to understand that process and its relationship to NDI's.

B. THE ACQUISITION PROCESS

The purpose of the acquisition process is simple. It is to develop, produce, supply and support weapon systems to achieve the operational goals of the Armed Services. The President establishes these goals as National Security objectives and policies. The resulting acquisition process involves making millions of procurement actions and spending billions of dollars each year. The size of this action requires close control and guidance.

The basic guidance for Department of Defense (DOD) acquisition programs comes from the President through his Office of Management and Budget (OMB) through Circular A-109 entitled "Major System Acquisitions" of 5 April 1976. A-109 embodies the recommendations of the 1972 Commission on Government Procurement to provide a standard organization policy to the Executive branch of the Government, including the Department of Defense (DOD).

The Department of Defense (DOD) expanded Executive guidance by developing two additional directives. The first is Department of Defense Directive (DODD) 5000.1 of 1 September 1987. Its title is "Major and Non-Major Defense Acquisition Programs." The second is DODD 5000.2 of 1 September 1987, known as "Defense Acquisition Program Procedures." These instructions expand A-109, and are designed to provide a single, uniform system for planning, designing, developing, procuring, maintaining and disposing of all equipment, facilities and services for DOD.

Identifying the precise beginning of the acquisition process is difficult. Programs begin in a variety of ways. A new system may start as a replacement for a system that has become obsolete. Government intelligence services may detect a new threat or mission that requires a system different from any yet designed. Also, new technology may emerge that forces the development of a new weapon system. Each military department would address the requirements with plans and recommendations through its Planning, Programming and Budgeting System (PPBS) in documents known as Program Objective Memorandums (POM).

Before Program Objective Memorandums are prepared and submitted through the PPBS process, services perform an activity known as Mission Area Analysis (MAA).

1. Mission Area Analysis

Mission Area Analysis (MAA) is an ongoing process of identifying a perceived threat, a change in technology, or input from operational personnel that results in a modification to an existing weapon system or provides the opportunity to develop a new system. National intelligence agencies may detect the presence of a new threat to security or users may report deficiencies in current designs or performance deficiencies of existing systems. However, most of the MAA is conducted outside the operational community. Research and Development (R&D) centers and commercial industry provide much of the MAA as a result of independent research and development programs and breakthroughs in technology.

One element of MAA is market surveillance. Market surveillance is the process of reviewing the commercial market for technology and systems that may fulfill operational requirements. No matter how well organized, DOD cannot normally duplicate the economies of scale possible in a mass market, nor the power of the free market system to select and perpetuate the most innovative and efficient producers. Due to their very nature, products developed uniquely for the military usually cost more than their commercial counterparts. Therefore, market surveillance helps the DOD avoid some of the costs associated with research and development efforts by purchasing goods and services directly from the industry.

Following MAA, the mission need is formally documented in a Mission Need Statement (MNS), an Operational Requirement (OR), or a Required Operational Capability (ROC), which defines the need for a new or modified weapon system capability [Ref. 1:p. 6].

2. Exploration of Alternative Systems

The process of finding the concept that best meets the mission need is helped if the requirement is described in general terms since it allows consideration of the widest range of possible solutions [Ref. 2:p. 17]. Once the POM or the PPBS process identifies a deficiency in the Navy's capability to meet a mission, a Tentative Operational Requirement (TOR) is developed. This document identifies a potential need for a new system. The Space and Naval Warfare Systems Command (SPAWAR) reviews the TOR for all System Commands. After the review, SPAWAR identifies the Warfare Systems Engineer (WSE) and Warfare Systems Architecture (WSA) standards [Ref. 3:p. 3-2]. These standards, in turn, identify the cognizant System Command for system development. This is necessary for preparing another document known as a Development Options Paper (DOP) which is prepared by the appropriate Systems Command, assigned by SPAWAR.

The DOP identifies a series of system alternatives or contains a presentation of cost-capability curves for key system parameters. The Office of the Chief of Naval Operations (OPNAV) decision makers can use this information in choosing the best concept(s) to meet the threat identified in the POM or the PPBS process. The DOP contains information on technical issues, logistics, schedule, and cost considerations for each proposed alternative. The DOP is the basis of the MNS. It recommends solutions for the threat identified in the POM or the PPBS process. It is at this point in the acquisition process that decision makers should consider using NDI's as part of their acquisition strategy when selecting alternative systems.

3. Mission Need Statement

The Mission Need Statement (MNS) serves, for major systems, the same purpose as the OR and ROC do for other-than-major systems. DODD 5000.2 specifies its format. The Mission Need Statement should include the following information:

1. The specific element of the Defense Guidance to which the system responds.

2. The mission of the system and the expected national security threat.

3. The known alternative solutions to the threat.

4. The opportunities for cooperation with foreign nations.

5. An assessment of the technology base for the known alternatives.

6. The funding requirements.

7. Any constraints or boundary conditions, and

8. The acquisition strategy. [Ref. 1:p. 3-1]

C. DEFINITION OF NDI

The 1987 National Defense Authorization Act defines NDI as:

1. Any item of supply that is available in the commercial marketplace.

2. Any previously-developed item of supply that is in use by a department or agency of the United States, a State or local government, or a foreign government with which the United States has a mutual defense cooperation agreement.

3. Any item of supply described in paragraph 1. or 2. that requires minor modification in order to meet the requirements of the procuring agency.

4. Any item of supply that is now produced that does not meet the requirements of paragraph 1., 2. or 3. solely because the item:

    a. Is not in use yet, or

    b. Is not available in the commercial marketplace yet.

The DOD uses various definitions, all similar to the statutory definition. The Army further segregates the definition into three separate categories:

1. Category A - Off-the-shelf items used in the same environment for which the items were designed with little or no development required.

2. Category B - Off-the-shelf items used in an environment different from that for which the items were designed.

3. Category C - Integration of existing components and essential engineering effort to accomplish systems integration with research and development to integrate systems.

The Federal Acquisition Regulation (FAR) defines "commercial product" as:

A product, such as an item, material, component, subsystem, or system, sold or traded to the general public in the course of normal business operations at prices based on established catalog or market prices.

The FAR defines "commercial-type product" as:

A commercial product (a) modified to meet some government-peculiar physical requirement or addition, or (b) otherwise identified differently from its normal commercial counterparts.

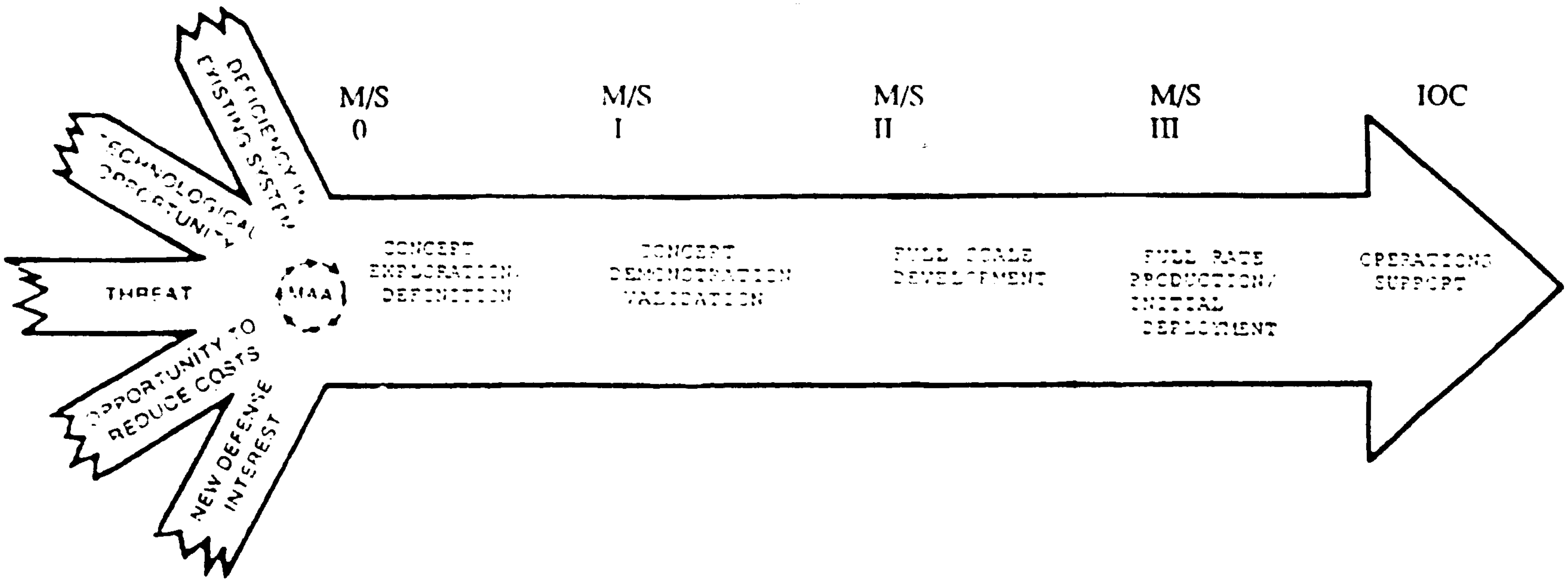
D. MILESTONE PROCESS

1. Milestone 0--Concept Exploration/Definition Phase

In the acquisition process, milestones are decision points along the development path that lead to production and deployment of a weapon system. The decision to move to the next phase is based on whether or not the system has successfully completed the preceding phase. Figure 1 is an overview of the milestone process.

At Milestone 0, the Mission Need Statement has been approved to start a new program. It is the first major decision point in the life-cycle of the new system and signifies the beginning of the Concept Exploration/Definition (CE/D) Phase.

The Concept Exploration/Definition phase is a busy time in a system's life cycle. The Service normally establishes a program office within 90 days of the start of this phase to develop, produce, deploy and support a weapon system. The program manager assembles a team to select alternative concepts and writes an acquisition strategy that addresses how the acquisition will be pursued. It attempts to identify



MILESTONE DOCUMENTATION:

0:	MISSION NEED STATEMENT (MNS) DECISION OPTIONS PAPER(DOP) TENTATIVE OPERATIONAL REQUIREMENT (TOR)	I:	SYSTEM CONCEPT PAPER (SCP) TEST AND EVALUATION MASTER PLAN (TEMP)	II:	DECISION COORDINATING PAPER (DCP) TEMP	III:	DCP TEMP

Figure 1. Department of Defense Acquisition Process

concepts with the greatest potential of meeting the mission need identified during MAA and documented in the MNS.

The program office completes the Concept Exploration/Definition (CE/D) phase in cooperation with industry, in-house Navy Research and Development (R&D) laboratories, universities, and contract research centers. The program office selects alternative concepts based on factors such as life cycle cost, development schedules, and performance characteristics. Most of the alternatives under consideration come from industry and the government uses in-house laboratories and research centers to review and evaluate concepts that have been submitted. The selection of the best concepts is based on their feasibility, technical risk, and cost tradeoffs.

a. Market Research and Analysis

Market research and analysis consists of researching the market for technology that is available to meet the user's need. On this subject, the FAR, part 11 states:

> Once the Government's needs have been functionally described, market research and analysis shall be conducted to ascertain the availability of commercial products to meet those needs and to identify the market practices, including warranty terms, of firms engaged in producing, distributing, and supporting these products.
>
> Agencies shall conduct market research and analysis as needed to assure adequate competition and that the Government's needs are met in a cost effective manner. The extent of market research and analysis will vary depending upon such factors as urgency, estimated dollar value, complexity, and past experience.
>
> When products meeting detailed specifications have satisfied user needs in the past, solicitations for commercial or commercial type products to fill the same requirement should include provisions allowing the former producers to be considered for award under the detailed specifications as long as the specifications are current and all potential suppliers are competing on a similar basis.

One way to do this is for the program office to award several contracts to evaluate the concepts that may meet the need. A successful CE/D should, therefore, uncover all NDI products and technologies available to satisfy the need. It also has a potential secondary benefit of shortening the acquisition process. In order for the NDI to meet that need, the following questions should be addressed:

1. Are there one or more NDI products available to satisfy a user's need? If none are suitable, can an item be modified or can the requirement be relaxed without degrading performance?

2. Can an NDI meet the performance requirements of a military tactical environment?

3. Are available products efficiently transportable on highway, marine craft, railroad, and aircraft in their operational configurations?

4. Are there suitable products available in enough quantities to meet government requirements without separate production runs?

5. Are there support systems, including parts and backup capabilities that satisfy government needs available for the life of the system? What if the contractor producing the NDI goes out of business?

6. What is the extent of competition for the item under consideration?

7. Are commercial standards and warranties adequate to protect the Government's interest?

8. Are commercial training, operating and maintenance manuals available and adequate?

9. Do companies making the NDI have a good product quality and logistics history?

10. Is the vendor willing to demonstrate the item at a government location?

11. Does the NDI incorporate accepted human factors engineering features?

12. Are commercial configuration management controls adequate?

13. Does the NDI meet safety, health and environment requirements?

14. Is the NDI disposable (e.g., disposal of hazardous wastes)?

15. Is there a structure in place for post-production support of NDI? If not, what will the maintenance requirements be and who will satisfy them: organic, commercial, mix? [Ref. 2:p. 20]

16. Does the NDI provide more than the user requirement at any cost to the Government? Is the NDI available in various configurations?

17. Does the NDI allow for any growth in capability, capacity, performance?

The results of early market research will shape the entire acquisition strategy.

b. Acquisition Strategy

The "Acquisition Strategy" is the program manager's plan for satisfying the user's need. The plan contains elements such as: program structure, requirements thresholds, priorities, resource availability, and who will have program review and decision authority. The use of an NDI in the acquisition strategy is impacted by these elements. For an NDI procurement, these elements fall into three categories--technical factors, business factors, and support factors.

Technical factors include methods for modifying the basic product, a description for soliciting vender proposals, the use of non-government standards for describing quality requirements of the NDI, criteria for technical evaluation, and requirements for a technical data review.

The acquisition strategy must also make effective use of the available financial and commercial resources. Factors associated with the use of resources are considered business factors. Business factors for the NDI include the most favorable delivery quantities over time, the acceptability of commercial qualification and quality assurance practices, special warrantee requirements, the distribution system, customer services, and the adequacy of packaging, handling, storage and transportation.

Support factors for NDI's include the distribution system for spare parts, a maintenance concept for the entire system that capitalizes on existing facilities and equipment, and an incentive system for commercial repair to minimize cost.

The program office must study the NDI solution carefully to determine how government use differs from its commercial use. Many times, government use will involve stressing the system in ways that the manufacture never envisioned. Therefore, an NDI solution may result in more logistic problems than it is worth.

c. *Integrated Logistic Support Requirements*

Integrated Logistic Support (ILS) activities must also be considered early in the development of a weapon system, especially where an NDI solution is being considered. The original system designer normally performs many ILS activities during CE/D. In using an NDI solution, the program manager does not have time to do a complete Logistic Support Analysis (LSA) and build a logistics program since the time between the signing of the contract and the delivery of an NDI is often accelerated. The Government will normally rely heavily on the contractor, therefore, the program office must carefully review the logistics costs associated with an NDI.

The document used to record logistic support considerations is known as an Integrated Logistic Support Plan (ILSP). An ILSP is a key factor in successfully fielding and supporting a system. It covers all the logistic activities for the life of the system, such as identifying training requirements, listing necessary support equipment and indicating calibration requirements for the system. These and many other logistic support elements become an agenda for building a support program for the weapon system.

Logistic Support Analysis (LSA) is a process that applies various techniques and functions to make sure that the system designer considers three important logistic functions--maintainability, reliability and supportability. These functions must be demonstrated. Maintainability is a characteristic of system design and installation and is formally defined as the probability that a system or item can be retained in, or restored to, a "ready for service" condition through maintenance. It is measured by a factor called Mean Time To Repair (MTTR). Reliability is the duration or probability of failure-free performance under stated conditions. It is measured by a factor called Mean Time Between Failure (MTBF). Supportability is the degree to which appropriately skilled persons, training, and resources are in place to minimize logistics-related delays within the maintenance process. Supportability is measured by a factor called Mean Logistics Delay Time (MLDT). These three factors form the basis of Operational Availability, which is a measure of readiness. It is the ratio of up-time to up-time plus down-time. MTBF is a measure of up-time and down-time is the sum of MTTR and MLDT. Therefore, Operational Availability is MTBF divided by the sum of MTBF, MTTR and MLDT. System readiness objectives and thresholds serve as the basis for evaluating the success of logistic support analysis planning. It is also the basis for making improvements to a weapon system if the objectives and thresholds are not reached.

Maintenance planning is the foundation for all other maintenance-related support planning. It must reflect design features in the maintenance concept. It is the process conducted to evolve and establish maintenance concepts and requirements for the life of the system. It also translates the maintenance approach into maintenance task requirements that will ensure the required availability of the system or equipment. For example, if an equipment has no ability to identify a suspected cause when it fails --no built-in-test capability--maintenance planning should identify a maintenance task to isolate the failure and list the tools needed to complete this task.

Manpower and training considerations must also receive special consideration in the logistic planning. The specific requirements for maintenance and support personnel are determined as part of the LSA process. This, in turn, drives the requirements for recruiting and training persons to support the system.

Another critical concern is supply support. Supply support includes the spare parts and the associated inventories necessary for maintenance of the system. Requirements are based on the maintenance level where repair is performed, the geographical location where spare/repair parts are stocked, demand rates and inventory levels of the spares, procurement lead times and the methods of distribution.

Support equipment is another important element of logistic support. These requirements must be identified early in the acquisition process. These include selecting calibration standards and tolerances, identifying the prime equipment functions that will be measured and repaired, and the intended maintenance environment. This allows the program manager to make funds available for buying this type of equipment and getting it to the maintenance and support facilities in time to use it.

Finally, the program manager must address the transportability requirements for the system. The program office must consider the methods for transporting and handling the system from the producer to the user. This includes consideration of temperature range, vibration and shock, and humidity experienced in transportation, the possibility of equipment degradation, and whether the system can be easily disassembled, packed, and transported from one location to another. In the DOD, logistics is an international business, and transportation requirements often involve the worldwide distribution of supplies. Therefore, the system may require unique packaging or specialized environmentally controlled containers for transportation.

The logistic tasks for a program will vary with the requirements and the specific need of the user. Program managers must provide certain minimum requirements for any program. The logistic support considerations are very different for an NDI than for a purely government developed system. The specific differences are discussed in Chapter III.

d. System Concept Paper

The System Concept Paper (SCP) summarizes the results of the Concept Exploration/Definition phase and nominates the best concept(s) to be tested and demonstrated in the next acquisition phase. The SCP also discusses the rational for eliminating concepts that have been deemed inappropriate, technically risky or too expensive to develop.

E. CONCEPT PROVE-OUT PHASE

The selection of a concept and approval to move into the Concept Prove-out Phase is a key event in the acquisition of an NDI. The Concept Prove-Out Phase replaces Concept Demonstration and Validation (CD&V) and the Full Scale Development (FSD) phases that are normally associated with non-NDI acquisitions. Primary considerations during Concept Prove-out Phase are (1) program alternative trade-offs, (2) performance/cost and schedule trade-offs, (3) appropriateness of acquisition strategy, (4) demonstration of the system or selected system components, (5) affordability and life-cycle costs, (6) potential common-use solutions and (7) cooperative development opportunities.

Once the acquisition strategy approves the use of an NDI, the program office then attempts to procure it. If the buying agency is procuring a Category 1 NDI--an item available from the commercial marketplace, without modification--the prove-out phase will attempt to demonstrate the availability factors of the selected item. The factors normally demonstrated are MTBF and MTTR. For NDIs modified for military use, the Prove-out Phase will also include testing and demonstration of the NDI until it meets the goals established during CE/D.

At the close of the Concept Prove-Out Phase, a production decision is reported in a document known as a Decision Coordinating Paper (DCP). It establishes the need for a production contract. Following the solicitation of contractors, proposals are evaluated using pre-established selection criteria. The final selection of a contractor should be based on a proposal that provides the best value to the Government, meaning that selection should be based on life cycle costs of the item.

F. PRODUCTION AND DEPLOYMENT

Once the contract is awarded and the NDI is pending delivery, the program manager must update the ILSP to ensure that the fielded system can be supported. Details of the ILSP will be discussed in detail in Chapter III.

Initial Operating Capability (IOC) is the point in time when the system can be operated and supported by the users. The transition process from production to operational use is a critical time in a program. The system, its ancillary equipment and the logistic support must all be in place at the same time. The goal is to meet user requirements and to provide an operational system that is ready to go at the required time.

The period of transition will vary in time depending on the complexity of the system. Its success depends on how well the ILSP has been prepared and updated as production begins. If the system is relatively simple to install, operate, and maintain, the transition may require only a few days before the user is able to assume full responsibility for system operation and support. On the other hand, if the system is large and complex, the transition may be much longer and accomplished on a gradual basis.

G. CHAPTER SUMMARY

This chapter described the Department of Defense acquisition process and addressed the NDI solution as an alternate acquisition strategy. It explains the similarities and differences between an NDI acquisition strategy and one using normal development. It also sets the foundation for examining the specifics of the research questions discussed in Chapter III.

III. RESEARCH QUESTIONS

Chapter II established a theoretical framework for the acquisition of Non-Developmental Items (NDI). This chapter examines the potential benefits of using NDI in that process. It also addresses special support considerations for NDI systems. It concludes by presenting the program parameters that indicate the type of support program that will work best for NDI systems. Responses received in interviews and through examination of acquisition literature are the basis of this chapter. Appendix A lists the questions asked during personal interviews.

A. NON-DEVELOPMENTAL ITEM DEFINITION

When asked to define the term "Non-Developmental Item" (NDI), those interviewed gave a fairly consistent answer. The answers were very similar to the definition presented in Chapter II. The simple definition of an NDI is "any item or equipment in which the user did not participate in its development". Using this definition, an item developed for one agency can be an NDI for another.

Another important aspect is how the acquisition of an NDI differs from a typical research and development acquisition. The consensus of those interviewed was that an NDI is not a separate process, but a tailoring of events within the acquisition process. NDI items should be one of the first alternatives considered as a solution to a material need, however.

B. HOW IS THE DECISION MADE TO USE NDI IN MEETING A MISSION NEED?

The decision to use an NDI to meet a mission need is not always difficult. Some requirements can only be met by an NDI. For example, The Army's Communications-Electronics Command (CECOM) at Fort Monmouth, New Jersey, adopted an NDI philosophy as its first choice in providing communications and electronics equipment for the Army. In this case, CECOM decided that all requirements must be met by off-the-shelf items [Ref. 4:p. 35]. The acquisition concentrated on finding the best commercial market solution to meet the mission need and they chose an NDI strategy because the expense of developing a system for the Army's unique needs was not perceived as being cost effective.

When the acquisition process identifies the need for a new hardware system, the acquisition process begins with the necessary requirement documents, including those which address the use of NDI candidates. The Tentative Operational Requirement (TOR) starts the material acquisition process by explaining how the system will be used, where it will be employed in the field, and how it is to interface with other systems. Although the program sponsor is responsible for the development of the TOR, the program manager is also actively involved. The program sponsor is assigned from one of the 13 Resource Sponsors located in the Office of the Chief of Naval Operations (OPNAV). The Resource Sponsor develops program appraisals for their perspective programs and are responsible for ensuring that their programs are effective, balanced and operated within fiscal controls. They also coordinate with other sponsors as required. The program manager is responsible to the Resource Sponsor for managing the specific program to which he is assigned. He uses the TOR as a basis for conducting market research of available technology.

Together they define and identify the essential operational characteristics that are incorporated into the Decision Options Paper (DOP), which essentially responds to the TOR. The program sponsor then selects recommendations from the program manager that best matches desired capabilities within affordability limits. This is the point in the program where an NDI can be selected as the alternative.

The Operational Requirement (OR) is the document that describes the characteristics of the alternative selected. The program sponsor prepares the OR in coordination with the program manager.

The program office determines tradeoffs in capabilities or characteristics in the OR. Both the sponsor and program manager must work together to formulate optimal system requirements.

1. Benefit to Acquisition Process

An NDI solution certainly affects Department of Defense (DOD) acquisition programs. The overall effect varies from case to case. In each instance, the NDI acquisition offers some advantages and some disadvantages as an acquisition strategy. The benefits attributed to NDI include lower development costs, shorter acquisition cycles and speeding up the delivery of new technology to the field. This section shall present some of the benefits of including NDIs in the acquisition process.

a. Lower Life Cycle Costs

NDIs are normally cheaper in the long run than systems developed exclusively for the Government. The lower life cycle costs of NDIs are due mainly to cost avoidance during the research and development phases of the acquisition process. An NDI usually costs less for three reasons: limited government R&D costs, the use of commercial specifications, and competition within the commercial market place.

The NDI strategy uses test and performance data provided by commercial manufacturers, users, and other Services, agencies or countries. This data must prove that the product is acceptable for the intended military application. As a result, limited testing is normally required to capture this benefit. Independent evaluators such as laboratories and research centers are often used to validate performance capabilities.

Commercial specifications often save many acquisition dollars. They save the Government costly development of test and historical data, technical publications, drawings, manufacturer's part information, quality, safety, and reliability data.

> There is no question that many military systems must operate in environments never encountered in the civilian sector, and the Service's demand for reliability far exceed those of most business/industrial applications. However, in many cases, the military specifications under which items are obtained significantly exceed those realistically required for the item to function in its intended role. If specifications can be reduced to the point where a commercial "off-the-shelf" item will work, significant savings can be obtained. [Ref. 5:p. 16]

Competition also helps to keep the cost of NDIs down. Many studies have shown that competitive pressures lead directly to the development of better systems at lower prices. Competition arises when markets have many buyers and sellers. Each buyer and seller is so unimportant in the market that their separate actions have no impact on market price. Unlike a typical acquisition process, NDI is uniquely structured to take advantage of the competitive forces in the market place.

The Government becomes another buyer in a market with many customers and many suppliers.

The program manager can project funding requirements more accurately when NDIs are part of the acquisition strategy. NDI programs stay on budget because they are theoretically off-the-shelf with prices that are firm. The program manager projects a schedule and a budget with minimum risk of being wrong. And since the NDI is a production item, the contractor and government team can concentrate on ways to reduce costs instead of worrying about typical development and test problems.

b. Shorter Acquisition Cycle

As depicted in Figure 2, the NDI acquisition life-cycle model takes an average of two and one-half years. This compares to the classical research and development cycle that can take up to 16 years for a major new system. [Ref. 6:p. 2] An NDI strategy saves time in the overall acquisition cycle of a weapon system. The real difference with NDI is that Concept Demonstration and Validation and Full Scale Development phases can be combined when a total NDI procurement is undertaken. This compresses a four to nine year cycle into a one to two year "prove-out" phase.

Once the program manager selects an NDI strategy, the second phase of the standard acquisition life cycle is skipped or compressed. This is due to the fact that the developer has already accomplished the R&D engineering, design, integration, integrated logistic support, and test and evaluation efforts.

At times, the full-scale development phase of the standard acquisition cycle may also be eliminated. By definition, the NDI will have confirmed the integration of sub-systems into the production process. In the case where the manufacturer must modify the NDI to meet the military requirement, the time frame of this phase is still reduced. The system developer must only demonstrate the capabilities of the modified NDI.

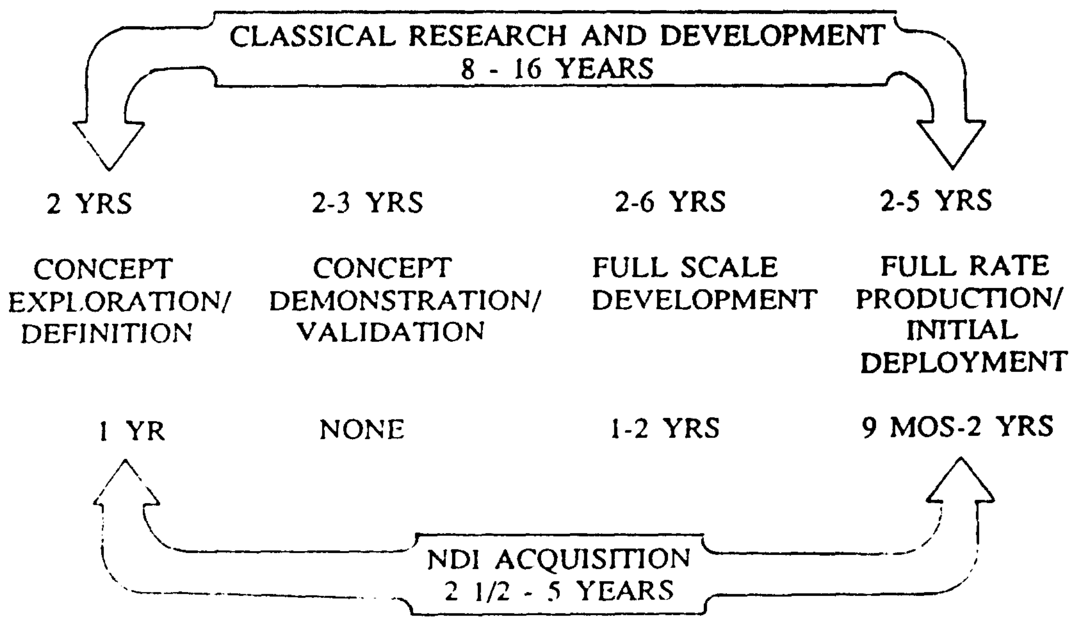


Figure 2. Acquisition Life Cycle Model.

The NDI acquisition also helps the program manager in the very important area of scheduling. Since the product is already realized, scheduling, testing and production is more certain than under a typical research and development process.

c. State-of-the-Art Technology

One additional effect of shortening the acquisition cycle is that current technology reaches the field sooner than under a normal acquisition. The long development cycles of major weapon systems almost guarantees that the fielded system is three to five generations behind commercial systems in state-of-the art technology. This shortcoming is especially evident in technical fields such as electronics.

d. Maintain the Production Base

The Government's industrial mobilization base consists of government-owned facilities and equipment and the supporting of private sector industry. NDI procurement broadens this private sector base and increases the number of defense contractors with limited government investment.

The manufacturer designs the NDI for the commercial world. When the military selects NDI to meet its operational requirement, demand for the item increases and the producer of the NDI would increase its production capacity to meet the greater demand. In the event of a mobilization, this extra capacity could prove vital to the nation's war effort.

e. Promotes Equipment Commonality

Buying commercial systems in use by another Service or nation enhances equipment commonality. When several government agencies buy the same NDI, the Government receives the benefits of commonality. The benefits include lower unit costs and lower support costs.

Equipment commonality decreases the logistics requirement for its users. Basic Ordering Agreements--which are contracts that set the terms and conditions for routine transactions that occur often enough to justify this flexible document--with the developer can achieve lower prices for spare parts and training materials for the Government. The lower prices save money for all agencies.

f. Complies with Statutes, Regulations

Many laws, instructions and directives establish a regulatory preference for NDIs. Studies of the DOD acquisition program commissioned by the President and the Congress have all recommended the increased use of NDIs. The appearance of waste and inefficiency can be less when the Government procures an NDI. However, a program manager must always keep cost, schedule and performance in perspective, and an NDI may not be the best alternative.

2. Detriment to Acquisition Process

NDI procurement is not a panacea for all acquisitions. NDI procurement poses some problems not associated with full development programs. Some of these problems are now presented.

a. Shorter Service Life

Many government funded developed systems have expected life cycles of 20 to 30 years. In the commercial market, the time horizon is much shorter and manufacturers do not always design equipment that will meet government needs.

Another factor in the shorter life cycle of NDIs is the difference between the military and commercial environment. The military environment is much more harsh than the normal commercial market place. Accepting a commercial NDI to fulfill a military requirement often means accepting equipment that is less rugged and will require some modification.

b. Compromised User Requirements

To take advantage of the cost savings offered by NDI, the program office often tailors the user's requirements, however they must guard against relaxing essential standards to accommodate commercial equipment. Conversely, trading off unrealistic specifications for substantial savings in time and costs is the backbone of the NDI program.

Many programs suffer from "requirements creep." Care in preparation of the original operational requirements is a must in order to avoid "add on" requirements as the system is developed. The OR must reflect neither the minimum essential requirements nor the maximum desired features. The OR must reflect the requirements necessary to meet the mission need.

c. ***Increased Safety Concern***

NDIs create increased concern regarding safety. This is due to the relaxation of testing before acceptance by the military. By its nature, the NDI is a system whose development the Government has not participated in. It is an item selected for a military application based on its commercial use. The program manager must adapt the item to a military application in a very short time since one of objectives of using an NDI strategy is to shorten the acquisition process. All these aspects place a considerable strain on the program office to meet both of these objectives.

NDIs generate a second safety concern because they may not meet Military Specification (MILSPEC) and Military Standard (MILSTD) requirements. Many of the requirements contained in these specifications are designed to assure DOD that safety and quality requirements have been thoroughly tested. Commercial specifications typically contain less safety and quality testing requirements. This is not to say that items built to commercial specifications are not safe or lack any quality but documentation is not available and therefore, further testing is required.

d. Less Time for Logistics

Logistic Support Analysis is the process of integrating and applying various techniques to make sure system design considers supportability requirements. An NDI approach surrenders part of this responsibility to the commercial developer. As a result, the buying activity must often rely on the developer for support after it is fielded.

3. Detriment to Logistic Support

Logistic support consideration for NDIs is the subject of this thesis. NDI programs are special because they can shorten the acquisition cycle. Selection of certain commercial items also reduces the interval between production award and initial delivery of the entire system to the user. The time required to prepare, staff, and approve program management documents, manpower estimates, and equipment authorization documents included in the establishment of an organic logistic support capability is often greater than the time actually required to produce and deploy hardware. When the process is accelerated through the procurement of an NDI, timely support is even more difficult to accomplish.

a. Hardware and Software Proliferation

The Government relying on the commercial market may purchase different systems to meet the same needs of two different agencies. For the purposes of illustration, consider the office typewriter. Many commercial firms manufacture typewriters. If a government agency had a requirement for one, it certainly would not *develop it from* a typical R&D approach. Instead, the agency would buy it directly from a manufacturer and save unnecessary R&D costs. But unless the agency specified some level of compatibility with its existing typewriters, they may end up buying a model that is not compatible with typewriters currently in use. This, in turn, causes a logistic support problem. The agency would have to buy and stock two different types of ribbons for these models. They would also require different repair services depending on which typewriter needed maintenance. Two types of typewriters may not seem too difficult to manage, but consider an office with hundreds of them to support.

Hardware and software proliferation is another example where systems are compatible or interchangeable and readiness is impacted. Standardization of equipment is an important consideration when one considers the impact it will have on repair parts. A Form Fit and Function (F^3) philosophy fits nicely into the NDI process. It says that requirements can be described in functional terms such as speed, range, weight and other performance characteristics. Therefore, NDIs that meet those requirements could be purchased. Unfortunately it also presents logistics problems when various systems need support. For example, a ship with two or three different types of fire pumps procured under a F^3 specification would be more difficult to support then if standard equipment were purchased. In this example, the ship is forced to carry several different groups of spare parts to support on board equipment. If the same NDI were purchased as the standard fire pump, logistics support is much easier to accommodate.

b. No Time for Logistic Support Analysis (LSA)

As mentioned earlier, a shorter development results when procuring NDIs and therefore, there is too little time for a formal LSA. The Government must then perform an abbreviated LSA or rely on the NDI developer for this analysis. An example of this problem is described in detail in Chapter V. The Logistics Applications of Automated Marking and Reading Symbols (LOGMARS) system was procured from Ibis Corporation. Delivery of the equipment began almost immediately after the contract was awarded. The program had many logistic support difficulties in the first years of use as a result fielding an NDI without proper support.

C. WHAT SPECIAL SUPPORT CONSIDERATIONS ARE NECESSARY FOR NDI?

In addition to spare parts problems, the fielding of NDIs can lead to other logistic support problems. For example, training personnel to operate and support a system can also be a problem. Efforts to overcome this problem must begin early in the development process so that operators and maintainers are ready to support fielded systems. Once again, the use of NDIs force the program manager to an accelerated decision.

The last special consideration of using NDIs is the availability of support items for the duration of its life cycle. Market research and analysis must assess the manufacturer's ability to sustain support over the life of the system. The program manager may choose to make a one time "life of type" buy of support items as the best support strategy for the system. A "life of type" buy is a one-time purchase of spare parts, designed to support a system for the remainder of its anticipated life.

For example, the Navy's Automatic Test Equipment (ATE) for repairing electronic and avionic "black boxes" makes great use of commercial test equipment. Equipment that has many common purposes such as oscilloscopes and volt meters are purchased off the shelf from commercial vendors and installed into the ATE. Many times, the manufacturers of these components have several upgrades to their systems. They usually provide spare parts and technical service for their equipment for several years after the model year, but the support usually cuts off much earlier than the normal 10 to 15 year life of ATE. In the case where a manufacturer stops supporting a commercial item embedded in a piece of Navy ATE, the program manager would be forced to choose between a "life of type" purchase of spare parts, a block upgrade to the new model or select a replacement system. No matter what the choice, it will be an expensive decision.

D. WHAT PROGRAM PARAMETERS ARE THE BEST INDICATORS FOR CHOOSING A SUPPORT PROGRAM?

There are four basic ways to support systems. The first is No Support (NS) or discard at failure. The second method is Organic Support (OS), where the Government assumes all the risk of system failure. In other words, the Government would purchase all the elements of logistics required to repair any possible failure of the system. The third is Total Contractor Support (TCS). A TCS decision results in the Government paying a contractor to bear the burden of keeping the system in an operational condition. The fourth method is to have some mix of contractor or organic support. Chapter IV contains a detailed explanation of these methods.

Two factors influence the support method selected decision. The first are system use factors; i.e., how, where, when, why and how long the system will be used. The second factors are system specific. These would include the system's availability, unit cost, population, complexity and maintenance concept. An explanation of these factors follows.

1. System Use Factors

a. How Is The System Used?

This factor reflects the degree of militarization. As the military version differs more and more from the commercial version, the benefits of NDI diminish. Also, the logistic support becomes more difficult. As the degree of militarization increases, the need for an organic support system increases.

b. Where Is The System Used?

This factor describes the environment in which the NDI operates. Hostile or benign are the two extreme environments. The system maintenance plan also addresses this factor. The closer the military environment is to the commercial environment, the more the military can rely on the commercial method of support.

c. How Long Is The System Used?

This factor reflects the length of the operating cycle for the system. The operating cycle drives the system's reliability. Longer operating cycles require systems with higher reliability. Since systems with higher reliability typically cost more and are more complex, they also need organic support. Therefore, longer operating cycles typically drive the system to an organic support requirement.

d. When Is The System Used?

This factor asks if the NDI supports a requirement now or in the future. Requirements that must be met now will be met by systems without organic support. Organic support is easier to establish for requirements projected into the future.

e. Why Is The System Used?

This factor depicts the mission criticality of the system. Is the system a back up for another system? Is the system essential to the combat mission of the user? If a system failure does not impact the routine of the user, the support of the system will be different from a system who's mission is essential to the user's success.

2. System Specific Factors

A model that determines the optimal method of logistic support for an NDI must consider more than system use factors. The model must also consider the unique characteristics of the system. These characteristics are System Specific Factors. A description of these factors is now presented.

a. System Availability Goals

System Availability is the measure of the degree to which a system is operational. It describes a system's ability to start a mission when needed. It does not, however, describe the system's endurance. Availability is a function of operating time (reliability) and down-time (maintainability and supportability).

System reliability is the probability that a system will perform satisfactorily for a given time period when used under specified conditions. System maintainability is an inherent design characteristic dealing with the ease, accuracy, safety, and economy in the performance of maintenance functions. System supportability relates to the degree to which the system can be supported. The system is supported by both the inherent characteristics of system design and the effectiveness of the overall support capability.

b. System Cost

System cost is Life Cycle Cost (LCC). LCC includes research and development costs, production and construction costs, operation and maintenance costs, and system retirement and phase out costs. Two broad categories segregate LCC. They are recurring costs and non-recurring costs. Recurring costs are the costs for each procured system. Non-recurring costs are those costs necessary to build the first system. Non-recurring costs include the R&D costs and portions of the other costs not attributable to individual units.

Recurring costs are those LCC attributable to individual units. These costs along with the maintenance costs will impact the maintenance concept of the system. The maintenance concept defines the logistic support of the system.

c. System Population

System population or the total number of systems effects the logistic support of that system. As the population increases, maintenance and support should become easier.

d. System Complexity

System complexity describes the degree of interdependency of system components. System complexity affects the maintainability and supportability of the system. As a system becomes more complex, maintenance on the system becomes more difficult. A complex system is more difficult to support than a less complex system.

e. System Maintenance Concept

Maintenance can be performed at one of three levels: Organizational, Intermediate, or Depot. Descriptions of the tasks associated with these levels of maintenance are contained in Chapter V. The maintenance concept defines levels of maintenance where repair of the system affects LCC. Maintenance is normally cheaper at lower levels. The lowest level is maintenance at the organizational level such as the shipboard or squadron level. Systems repaired at higher maintenance levels like Intermediate Maintenance Activities or Depots usually have higher maintenance costs and higher LCC.

These are the factors that the program manager must consider when choosing a support method for any system. In an NDI procurement, the program manager must make a special effort to chose the correct support method because the shortened acquisition cycle does not allow for development of a normal support system. If the program office picks an organic method or an organic/contractor mix, it will need to invest time and effort early in the program to make sure that an appropriate support system is in place by the Initial Operating Capability (IOC) of the system.

E. CHAPTER SUMMARY

This chapter addressed the research questions of this thesis. It uses information gathered from interviews with logistic managers of current programs and a review of the current acquisition literature. The factors identified as indicators for choosing a support program will be the basis for the support decision model in Chapter IV.

Persons interviewed answered the questions contained in Appendix A. The information they provided made the foundation of this chapter. The support decision model in Chapter IV also contains information gained from these interviews.

IV. THE SUPPORT SYSTEM DECISION MODEL

A. INTRODUCTION

One of the greatest challenges facing the military officer is to meet the growing need for more effective and efficient management of our resources. The requirement to increase overall productivity in a resource-constrained Navy has placed emphasis on all aspects of program management, and logistics has assumed a major role comparable to research, design, production and system performance during operational use. The need to address total system life cycle cost (in lieu of acquisition cost only) is evident, and experience has shown that logistic support is a major contributor to life cycle cost.

Further, experience has indicated that a great deal of the impact on the projected life cycle cost for a given system or product stems from decisions made during the early stages of advanced system planning and conceptual design. Decisions at this point have a major effect on activities and operations in all subsequent phases of the life cycle. Figure 3 depicts how these decisions impact life cycle costs (LCC). In Figure 3 the upper line shows the impact of decisions on life cycle costs and the lower line shows cumulative system expenditures. The concept chosen to meet the mission need is seen to lock in approximately 70 percent of the system's LCC. However, at the point when the concept is chosen, shown as Milestone 1 in the figure, only a small amount of the system's total LCC have been expended [Ref. 3:p. 1-9]. Given the cause-and-effect relationships and the fact that logistics costs may assume major proportions, it is essential to address logistic support issues in the early phases of the system planning and design.

Non-Developmental Items offer no opportunity for logistics to impact design. Program managers for these systems must decide as early as possible in the program which support method to use for their program. This model may help the program manager or the logistician: (1) to support the system or provide no support, and (2) which support method is best suited to the given situation. The Support System Decision Model (SSDM) is based on a decision model developed by LCDR D.S. Parry and LCDR B.R. Sellers for selecting second production sources under sole source conditions [Ref. 7:Chapter V].

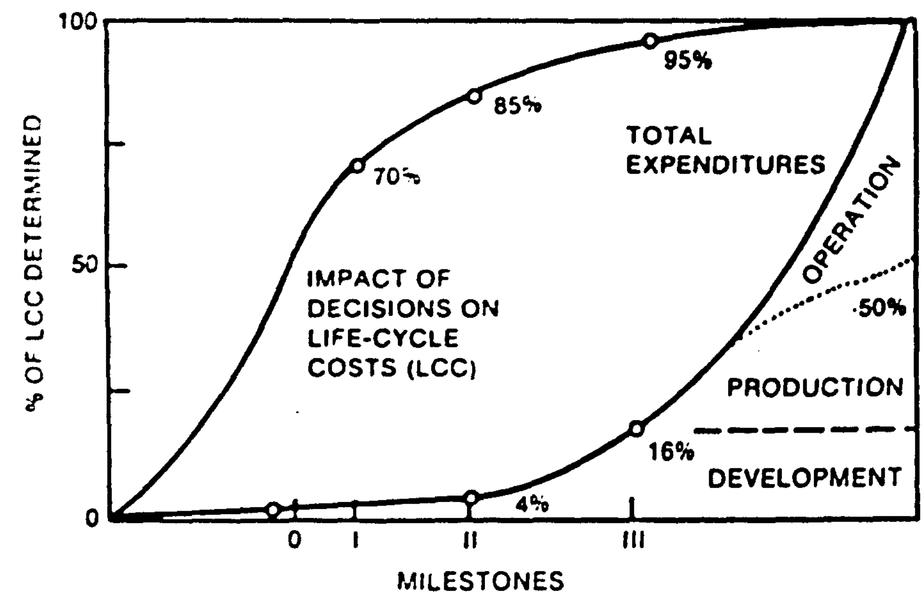


Figure 3. System Life Cycle

The following topics will be discussed in the remainder of this chapter: methods of supporting NDIs, factors affecting the support decision, and, the model itself. This includes its format, the rationale behind the effectiveness factors of the model, and a discussion of the actual use of the model.

B. METHODS OF SUPPORTING NDI SYSTEMS

This section discusses four methods which can be used to provide logistic support for a Non-Developmental Item. Each method has advantages and disadvantages. The four methods described are: (1) discard system and equipment upon failure (no support); (2) total contractor support; (3) organic support; and (4) a combination of organic and contractor support. When possible, the decision regarding the support method should be made as early as possible in the life of the program so that the production contracts may be structured to facilitate the purchase of support items or engineering data. If the program manager chooses to delay the support system decision, he may encounter a significant logistic support problem when the system is fielded.

1. No Support (NS)

This support method works by *not* repairing equipment regardless of the type failure. Upon failure, the user replaces the system with a spare. Items designated to receive this method of support are called "non-repairable items." This support method is also known as "throw-away" maintenance. This name applies, even if the item may be repaired (i.e., repair is possible, but the person deciding the maintenance concept has chosen not to repair the system.)

A non-repairable system is usually modular in construction. Also, failure modes are such that the failed component is easily identified. In other words, fault detection and fault isolation are easy. In this case, a positive built in unit self test capacity will be important. It must have a high self test thoroughness to confirm failures before discarding the system. Otherwise, when a user suspects a failure, he may throw away a unit that has not failed. This could be costly.

Another typical characteristic of a throw-away system is its relatively low cost. But low system cost does not necessarily drive a system to a throw-away maintenance concept.

Another system attribute that helps the no-repair method is easily removable sub-components. Since the user discards the system when it fails, techniques like hermetically-sealed components are not a problem. These reliability-enhancing methods that protect against humidity and corrosion also improve the reliability of the unit. Also, there is no need for internal accessibility, test points, plug-in sub-assemblies or sub modularization or other maintainability enhancements. No trade-offs between reliability and maintainability are required.

This support method requires minimal logistic support. No lower level spare parts are necessary. Test and support equipment requirements are limited to that necessary for initial system check-out and ready-for-use certification. No maintenance test equipment is required. Low personnel skills will suffice since maintenance is limited to a remove and replace function. Maintenance manuals are simple and unit maintenance is not covered. Choosing this support method implies that the cost of spare units and disposal is cheaper than repairing the system to a ready for use condition.

Although throw-away policies for reparable type items are generally perceived as wasteful, this concept should not be discarded based solely on tangible cost analysis.

During periods of conflict, the throw-away concept could become more mission effective than using a peacetime repair concept. This decision would be influenced by the mission, timing, etc., as well as other factors such as the availability of transportation, and production capability of the industrial base.

If the system is not to be discarded upon failure during peacetime, a repair concept must include one of the other three support methods. However, when a total discard-upon-failure or throw-away concept is used in peace time, as well as wartime, there will be no impact on the cataloging system because there will be no support items to enter the system. Further, no impact is envisioned in other logistical areas solely because of NDI acquisitions. Configuration control is not an issue since a new procurement will only specify system requirements to form, fit, function, and internal design changes will not matter. In fact, buying to the existing commercial market will ensure obtaining the latest technology, but could impact training due to introduction of new models.

2. Total Contractor Support (TCS)

This method involves establishing contractual responsibility for all system maintenance with a contractor. If an item fails, the Government simply notifies the contractor and the contractor restores the equipment to working order. The price for this service is considerable but the benefits are also large. Namely, the Government is protected from the risk of any failure for the life of the maintenance agreement. In this method, reliability trade-offs for maintainability should be reflected in the price of the maintenance contract. In other words, if the developer of the system has made it easy to repair, (and as a result, a little less reliable) the charges for maintenance support should reflect this condition.

Total contractor support will work well for systems that are too expensive to discard upon failure, but for other reasons, an organic support capability is not desirable. In systems where the relative frequency of failures is low, total contractor maintenance may be appropriate.

As it was for the throw-away method, the logistic requirements for this method are not significant. Spare units for the system are stored on site or held by the contractor. The Government would not require tools or test equipment. The contractor provides certification of ready for use for the systems. The contractor would perform repair on the government site or the unit could be moved to the contractor's site for repair.

There are some characteristics common to equipment that is best supported by total contractor support. Equipment that is too expensive to repair on a small scale is typical for systems supported by total contractor maintenance. These systems will also tend to be relatively reliable as a population. This support method is also appropriate for systems with especially high salvage and scrap value.

The mission requirements of the system greatly influence the decision to have all supply and maintenance support performed by a contractor. A total contractor support concept is more applicable for systems operating in a non-combat environment. In this support scenario, DOD would not provision for any spares and repair parts nor develop any maintenance strategy. No new items would enter the inventory. However, the program manager must consider impacts in other logistic areas when this method is chosen. In accepting total dependency on the contractor for support means accepting risks of excessive costs, quality instability (internal design changes and substitute components), untimely and inadequate support, and system upgrade to costly later models/designs which offer no basic mission advantages. DOD's ability to control system configuration declines as we move away from military designed systems.

The commodity area also greatly influences the support concept decision. Contractor support may be the best option in high technology areas where maintaining the state-of-the-art is critical, e.g., computers and associated peripherals and software. The Air Force has found that traditional methods of logistics support are not appropriate for their commercial computer systems. The proliferation and exponential growth of commercial computer systems in the Air Force demand support techniques that are prompt and maintenance effective without being cost prohibitive. The Navy has experienced a similar change of heart in its LOGMARS program. This case is presented in Chapter V. The LOGMARS system in the Navy expanded to the point that TCS was too expensive. By changing the support to a Mix of organic and contractor support and having the contractor charge for repair on a per-incident basis, the Navy reduced its annual support budget for LOGMARS from $590,000 to $163,000.

3. Organic Support (OS)

In this method, the Government develops a complete support program and solely bears the risk for system failure. In this support method, the Government performs all levels of maintenance on the system. The investment for this support method can be very large, but it may also be less expensive and more effective than the other methods. To develop an organic support capability, the Government would need to invest in the facilities and equipment necessary for the repair. Additionally, the Government would need to obtain the technical engineering data for the system. This information would be necessary for many parts of the logistic support program. The data provides the basis for training system operators and maintenance persons. It also would be necessary for establishing sources for spare components and parts. Technical data is also the source of the maintenance plan. Additionally, the logistic support analysis process makes use of the technical data.

Once the program manager obtains the technical data, it would have to be used to generate all those items just listed. These items are necessary for developing an organic support capability.

The organic support capability is not the proper choice for every system. Nor is it even the choice given first consideration. Actually, this method is reserved for those systems that have relatively high failure rates and a large population. Also , the requirement would need to exist for a long time to justify the investment. Additionally, and quite obviously, the system would have to be repairable or offer some value in salvage or scrap. Although the other factors are significant in choosing an organic support method, a very important factor is when the system is needed. If the system is needed for a future application, the Government will have time to develop an organic capability. For requirements that must be met immediately, the organic support method will be difficult to establish in a short time.

Organic support has long been the preferred method for the Navy. Organic support in some cases will still be the best and most viable support option for NDI systems. However, trade-off analyses must be made. The mission requirement influences the degree of configuration management (design stability) required which influences the support concept. Systems operating in a hostile environment generally must be ruggedized or militarized to improve reliability and sustainability. Traditional logistics presupposes that organic support is the mandatory option. Again, this may be true for some systems and generally can be accomplished for all systems if cost is not a consideration. But realistically, DOD managers must recognize that efficient and effective organic support depends on their ability to influence system design and parts selection. Otherwise, we accept the risk of costly sole source parts supply, including maintenance manuals and testing equipment or costly acquisition, if available, of technical data and a system design freeze to a baseline with additional costs to maintain a production base.

4. *Organic and Contractor Support Mix (Mix)*

This method of support combines two previously discussed support methods. It seeks to take advantage of the benefits of both total contractor and organic support methods while avoiding some of the disadvantages of each. This method involves sharing the risk of system failure between the Government and the contractor. In this support method, the maintenance responsibilities may be shared in any manner that is beneficial to the Government. Typically, the Government as the user, assumes the organizational maintenance tasks. These tasks normally include inspection, servicing, lubrication, adjustment, and the removal and replacement of parts, minor assemblies and sub-assemblies.

Also typical in a mixed support method is the contractor being assigned the depot maintenance function. Depot maintenance is those tasks that are beyond the capability of the lower levels of maintenance. Its tasks include inspection, test,repair, modification, alteration, modernization and overhaul of the system.

The intermediate maintenance tasks may be assigned either to the Government or the contractor in a mixed system. Typically, the Government would take responsibility for intermediate maintenance tasks if the capability already exists within the supporting activities or if the capability is easily obtained. Otherwise, the contractor would be assigned these tasks. The intermediate maintenance level tasks are calibration, repair or replacement of damaged or unserviceable parts, components, or sub-assemblies and providing technical support to the organizational activities.

This support method would be best for those systems that do not fall into the throw-away category, but are also not best served by a total contractor support method. These systems might have enough failures to justify some organic capability but a complexity that makes an organic method difficult.

A contractor and organic support combination allows for variations in the type and degree of support provided by each. As an example, all maintenance beyond simple organizational diagnostic tests could be performed by the contractor using government supplied parts. In this case, DOD has inventory management of spares and repair parts but does not have any maintenance responsibility. Configuration control is important here in order to reduce the variety of items or systems entering the supply system. This support mix would be more applicable to long life cycle systems not subject to rapid state-of-the-art technology changes.

In the reverse situation, where the contractor supplies the parts and DOD performs the maintenance, configuration control would be difficult and controlled by the contractor; however, standardization and stabilization of maintenance processes and manuals would be controlled by the Government.

A phased support schedule can also be considered a support combination mix. In this instance, initial support is provided by the contractor until the system is smoothly transitioned to organic support or to a support mix. Normally, timing considerations would be the primary force behind a phased support decision.

C. VARIABLES AFFECTING THE LOGISTIC SUPPORT DECISION

The selection of the "best" method for supporting the NDI system will vary depending on a number of factors that exist in the acquisition program. The existence of these factors (i.e., decision variables) presents the program manager with a difficult, multi-faceted decision situation. He must consider the strengths and weaknesses of each support method in relation to the influence of the variables in the acquisition program.

In order to assist the program manager in logically and systematically selecting the optimal support method, an evaluation model is needed. The model should rank each of the support techniques against each of the decision variables. Then, by objectively evaluating the influence of each of the variables, the program manager can make a choice of which method of support to use in his program. At a minimum, one or two methods may be shown to be clearly superior to the others, which makes the decision easier.

The next section presents such a model. Before describing the model, the decision variables on which the model is based and the general impact which each of the variables has on the feasibility of logistic support must be understood. Two types of factors influence the support method decision. The first type of factors are the system use factors (i.e., how, where, when, why and how long is the system used) [Ref. 8:p. 11]. The second type of factors are system specific factors. These factors would include the system's availability, unit cost, population, complexity and maintenance concept. An explanation of these factors is contained in Chapter III.

D. THE MODEL

The Support System Decision Matrix (SSDM) shown on the following pages is heuristic in nature. Its objective is to provide a logical and systematic framework for evaluating the applicability of each of the support methods in light of the variables present in the acquisition process. The end result of the evaluation process will be (at best) the selection of the optimal support technique. At worst, the model should serve to eliminate one or more support techniques from further consideration. In that case, the decision situation will have been simplified and certain variables should emerge as being critical, thereby, suggesting the areas which need further investigation or consideration.

1. Format of the model

The SSDM lists the 10 decision variables vertically on the left. Each of these variables is divided into two or three categories (e.g., high-medium-low, yes-no) to allow the model to be tailored to the refinements of a given acquisition situation. Across the top of the model are listed the logistic support methods. It should be noted that the four methods, (NS, TCS, OS, and Mix) when placed in that order, represent a line of continuum with respect to coordination required to achieve a successful support program.

2. Effectiveness Factors

The model rates the effectiveness of each of the methods with respect to the decision variables. A simple three point system of "+", "0", or "-" is used to denote whether a given method is particularly strong, neutral, or weak with respect to each of the variables. In addition, an "X" is used to denote a situation where the use of a given method is particularly inappropriate, or, to caution that particular care should be given in applying a given method in that situation. An "*", on the other hand, indicates that the method is particularly well suited to the situation under consideration.

The three point system is used because of the non-quantifiable nature of the model. The purpose of the model is to guide the program manager in choosing among the methods. It is not intended to provide an elaborate quantification scheme or to replace experience and judgement.

E. DISCUSSION OF THE MODEL'S WEIGHTINGS

1. Degree of Militarization

This factor indicates the extent of change that was necessary for the NDI to be made able to fill its military mission. The more changes that are incorporated into the NDI system, the less the contractor's standard support services will be sufficient or economical. This would drive the system towards a contractor-organic mix, or a total organic support method if the change were large.

2. Environment

This factor is divided into two categories: hostile and benign. If the NDI system is to be used in direct combat operations, a total contractor support method may be impossible. It would be difficult to bring a contractor into a combat environment to provide service. But a total contractor maintenance service is not impossible--systems can be removed from the battlefield to a more benign environment. The benign environment favors total contractor support. The cost of this service in a benign environment would not include the cost of training support persons in combat techniques. But combat training may be part of the cost for organic support.

3. Operating Cycle

Long operating cycles for systems usually indicate a mission of a routine, ongoing nature. For systems that fall into this description, service cycles can be planned in advance, which makes total contractor support easier than for systems with short cycles. Short operating cycles generally, but not always, indicate intermittent, randomly scheduled missions. Also, these systems tend to spend a great deal of time in stand-by status. For these systems, support services can not be conveniently scheduled in advance. Systems with short operating cycles are better served with an organic system.

4. Application

This factor indicates whether the NDI system is being procured to meet a present requirement or if the system will meet some future need. For systems meeting an urgent need, for a present requirement, an organic support capability may not be possible. An organic capability may take several years to establish. These systems may be forced to be supported by a throw-away policy. For systems being procured for a future requirement, the organic system may be established.

5. Criticality

This factor describes the relationship between the NDI system and the primary system. For systems that are a major contributor the primary mission of a war-fighting unit, the organic support method will probably best serve this system. As the criticality factor moves from secondary mission or back-up, finally to administrative, the support method may be changed to a contractor mix, total contractor support, or throw-away.

6. Availability

High system availability tends to make a no-support system or a total contractor maintenance program more effective. As system availability decreases, an organic system or a mix of organic and contractor support is more effective.

7. Cost

All other things being equal, high unit cost means the system must be repaired on failure. But high unit cost alone does not indicate which of the other three support methods will be preferred. Systems with high costs will be supported in some fashion. Conversely, low unit cost is better served by a throw-away system.

8. Population

This factor, with reliability, are very important factors in determining the support method for a system. As a system's reliability decreases and its population increases, the number of broken systems needing repair increases. At some point, it is more economical to develop an organic repair capability for a system. When the system population is small, it is usually more efficient to discard the system when it fails or hire the contractor to support the system. As the population increases, all other things being equal, it becomes more efficient to develop partial or full organic capability.

9. Complexity

Organic support is limited by the specialty structure of the service. If the skills necessary for the support of the system are not easily provided from the existing rate structure, the service must rely on commercial support. The return on the investment for developing an organic repair capability on simple items is easier to achieve than the return for repairing complex items.

10. Maintenance Level

This factor describes the level of maintenance where the majority of system repair will occur. When most of the maintenance man-hours are expended at the organizational or user level, then a NS system would be favored. For repairable systems that require higher levels of maintenance, such as the intermediate (I level) or depot level (D level) for repairs, then some level of support is required.

For systems that are mostly repaired at the I level or D level, a Mixed support system would be preferred. In the case where most of the repair occurred at the I level, the Government would develop an organic I level capability and contract the D level.

F. CHAPTER SUMMARY

This chapter presented the Support System Decision Model (SSDM). This simple heuristic weighs only ten characteristics of the system under consideration and each factor is weighted equally. In other words, it considers the degree of militarization to be equally as important to the support system decision as system availability. In some cases, this may be an erroneous assumption. It is important to understand that this model must be used with discretion and should not be the sole criteria in picking a support method. A demonstration of how this model may be used in presented in Chapter V.

SUPPORT SYSTEM DECISION MATRIX

Factors		Support Method			
		NS	TCS	OS	MIX
Degree of Militarization	High	0	0	+	+
	Low	0	+	0	0
Environment	Hostile	*	-	+	0
	Benign	0	+	0	0
Operating Cycle	Long	-	0	0	+
	Short	0	+	+	0
Application	Present	0	0	X	0
	Future	0	+	+	+
Criticality	Essential	-	-	+	0
	Important	0	0	+	0
	Accessory	+	+	0	+
Availability	High	+	0	0	0
	Low	0	+	*	+
Cost	High	-	0	+	+
	Low	+	-	-	-
Population	High	-	-	*	0
	Low	+	+	-	-
Complexity	Complex	0	+	-	+
	Simple	-	-	+	-
Maintenance Level	O Level	0	-	-	-
	I&D Level	-	+	0	+

V. CASE STUDY

The following case provides an illustration of a system procured as an NDI. It demonstrates some of the advantages, disadvantages and other considerations discussed throughout this thesis.

A. LOGISTIC APPLICATIONS OF AUTOMATED MARKING AND READING SYMBOLS (LOGMARS)

LOGMARS is the Logistic Application of Automated Marking and Reading Symbols in management information systems. From over 40 candidate symbologies, the Department of Defense chose the 3-of-9 bar code (3 of the 9 elements are wide and the remaining 6 narrow) as its standard [Ref. 9:p. 1]. This code has full alpha-numeric capabilities and is self-checking and discrete. It provides for 44 data characters, each of which consists of 5 bars and 4 spaces, for a total of 9 elements. It is also inexpensive and machine readable. It makes possible the rapid, accurate transfer of data; eliminates punch-cards and paperwork; and permits direct input of data to existing computer systems [Ref. 10:p. 7].

1. Background

The Department of Defense purchased LOGMARS in May 1982 from Ibis Corporation. The U.S. Army Computer Systems Selection and Acquisition Agency issued the contract which provides for hardware, hardware maintenance, software, software maintenance, training, and documentation. The Navy used the contract to buy almost $8 million dollars worth of equipment. The majority of the items were portable bar code readers.

The equipment bought on the Ibis contract is typical of commercially available bar code readers, scanning devices, and printers. In general, the equipment is quite reliable. The bar code readers and other electronic equipment are largely of solid-state construction and have few moving parts. This design lends itself to a high degree of reliability and relatively few maintenance tasks can be performed at the organizational or intermediate level. The label printers are impact-type printers and, because they are mechanical, they require more maintenance. The estimated life expectancy of the aggregate of the equipment was expected to be 10 years.

As the number and dollar value of these systems being installed throughout the Navy began to grow quite large, the Naval Supply Systems Command (NAVSUP) decided to assess the support program for this system. LOGMARS equipment was not designed or developed to a system specification, but procured off-the-shelf. The Integrated Logistic Support (ILS) Plan was formulated in the absence of maintainability, reliability and other support data normally provided in a full development program.

The Navy LOGMARS program is managed by the LOGMARS Program Management Office (PMO) at NAVSUP 0613. This office develops the Navy LOGMARS policy. In 1986, the program office determined these problems with the LOGMARS program:

1. Equipment maintenance was costing the Government over $500,000 dollars a year. This maintenance is being performed by Ibis, the only designated depot for this equipment.

2. Four years into the program's life and the Navy supply system had not yet started to carry parts and supplies for the LOGMARS. Most activities bought necessary items from local sources and usage data had not been maintained.

3. There was no central repository for LOGMARS technical data. No office was charged with making sure the users and maintainers had complete and current technical data.

After reviewing the program and identifying the support problems, the Navy LOGMARS Program Office had to consider several options. The program office could continue to fund total contractor support at a cost of over $500,000 per year; they could develop an organic capability within the Navy to support the system at some unknown cost; or, they could consider some mix of organic and contractor support for the system. Since LOGMARS equipment was designed for commercial application and support, the scope of the analysis focused on those elements that could be addressed at that point in the life cycle of the system:

1. Equipment maintenance
2. Supply support
3. Technical data

2. Equipment Maintenance

A maintenance plan establishes the responsibilities, support levels and repair policies required to maintain a desired level of equipment or system availability. In general, there are three basic levels of maintenance.

Organizational maintenance: Tasks that are performed at the user level and are normally limited to component replacement, preventative maintenance, and simple corrective maintenance.

Intermediate maintenance: Tasks that are beyond the organizational capability and usually include removal and replacement of major assemblies or parts.

Depot maintenance: Tasks that usually include restoration, overhaul, or rebuilding of equipment.

At the time of the analysis, equipment maintenance was included in the Ibis contract. The contract allowed for only two levels of maintenance for LOGMARS equipment: (1) the organizational level of maintenance, which is prescribed in the vendor's literature and performed by the user, and (2) depot level maintenance, which is performed by the contractor, at either the government site or on the contractor's site. And even though the contract specified organizational level maintenance, it was only the action of calling the contractor when a failure occurred. Contract maintenance was charged as a set fee on a monthly basis.

In considering the options, establishing an organic capability was almost immediately discounted. There were several reasons for eliminating organic support as an option. First, the LOGMARS equipment was actually quite reliable and depot level support facility for the number of systems the Navy had was not justified. Another important reason was the time required to convert to an in-house maintenance program. Collecting repair cost data, determining manpower needs, establishing positions, and providing training and equipment would take an estimated 4 years. With an anticipated service life of 10 years, the equipment already purchased and fielded would barely have any useful life by the time support could be achieved.

Continuing total contractor support was another consideration for the program office. The contract maintenance agreement requires the contractor to assume full responsibility for repair costs. If an item fails, the Government simply notifies the contractor, and the contractor does whatever is needed to restore the equipment to working order. The price for this service is considerable. The benefit is also considerable, in that it allows the Government to divest itself of any risk of failure for the life of the maintenance agreement.

The final consideration was finding some mix of contractor and organic support that was acceptable to the program office. By default, this was to be the method of support chosen. Organic support was not feasible because of the long period necessary to establish it, and total contractor support was too expensive.

To achieve a mix, the using activities needed to assume a greater role in the support of the system. As a result, organizational maintenance was redefined to include diagnosis, replacement, calibration, and adjustment of the equipment. Additionally, they would use the contractor's telephone consultation service to confirm and diagnose malfunctions and identify possible solutions. Items identified as not repairable at the organizational level would be either returned to the contractor or repaired on site by the contractor. Items determined after consultation with the contractor to be unrepairable would be disposed of at the organizational level.

Depot maintenance would only include major component repair or calibration beyond the capability of organizational maintenance. All work done by the contractor would be charged to the Government on an agreed-upon hourly rate.

3. Supply Support

Supply support consists of all material and catalog data required to sustain a system's operations and support. It include repair parts, spares, provisioning, storage, cataloging and consumable supplies. In the case of LOGMARS equipment, supply support was largely confined to consumable supplies, such as print wheels, ribbons and repair parts. Though the organic maintenance support for LOGMARS equipment is limited, items listed in the manufacturer's literature as replaceable by the user can be stocked by the using activity. These activities are now supplied largely from local procurement and the General Services Administration (GSA) schedule.

Ideally, the LOGMARS PMO should have taken steps to catalog and capture demand for these supplies. The data could have then been submitted for inclusion in the standard Navy supply system. Standardizing supplies within the wholesale supply system would enhance availability and reduce processing time. Since the production contract for the next family of LOGMARS equipment may be awarded to a different manufacturer, it would be helpful as an interim measure for the LOGMARS PMO to publish a list of acceptable supplies and sources of supply for distribution to the users.

To ensure availability of equipment for shipboard and other critical LOGMARS systems, an equipment maintenance float should be considered. A maintenance float stock is a quantity of spares or components kept as a standby to prevent downtime when primary equipment is evacuated from the using activity for repair. The LOGMARS PMO should assist the Applications Program Developers in determining the float requirement.

4. Technical Data

Technical data is the documentation for operation, maintenance, and support of a system. There is no central repository of this information for Navy LOGMARS systems. The LOGMARS PMO established a database of information on the system and maintains technical manuals for all system components. Establishing and maintaining a central office for this data provides a single source of information for all system users and system designers.

B. ANALYSIS

LOGMARS is a case where the Navy purchased a system off the shelf with little regard for the logistic support of the system. After fielding almost eight million dollars worth of equipment, the program office found the annual support costs for this system approaching $600,000. Weighing the factors of the program--factors that form the basis of the Support System Decision Matrix (SSDM) in Chapter IV--the program office considered the possible alternatives for support and chose a mix of organic and contractor support. The LOGMARS case is now evaluated using the SSDM developed in Chapter IV. The results are displayed in Exhibit 1.

1. System Use Factors

a. How Is The System Used?

This questions asks how the system is used compared to the purpose for which it was originally designed. In this case, LOGMARS is used exactly as it is used in the commercial market. Its degree of militarization is low. Therefore, ignoring all other factors, a Total Contractor Support (TCS) method would be favored. It is also noted that this factor is weighted neutrally against the remaining support systems: No Support (NS), Organic Support (OS), and a mix of organic and contractor support (Mix).

b. Where Is The System Used?

Where the system is used describes the environment in which the system is operated and maintained. LOGMARS operates in a warehouse atmosphere under benign conditions. Operation in a hostile environment is not expected and does not effect the support decision. This factor favors all the support systems except NS. The benign environment is neutral to the No Support decision.

c. How Long Is The System Used?

This factor describes the operating cycle for the system. LOGMARS has a long operating cycle reflective of its routine, ongoing mission. The long operating cycle of LOGMARS indicates that the Navy should consider some form of organic support, either a complete organic system or a mix of contractor and organic support. The model weights TCS neutrally and indicates NS is not favorable.

d. When Is The System Used?

This question asks if the system supports a present requirement or a future one. The more urgent the requirement is, the more difficult it is to establish an organic support capability for the early life of the system. In this case, an NDI strategy was chosen, in part, to get a working system in Navy warehouses quickly. This meant that any organic support would have to be phased in--brought in gradually. Initial requirements that could not be met with present organic capability would have to be met with contractor support.

e. Why Is The System Used?

This question weighs the criticality of the system to the mission of the user. LOGMARS is essential to the success of the warehouses that use the system. When the system fails, the user is forced to use a manual system that all but brings service to a halt. TCS could be used but is not favored because of the high cost that goes with keeping an essential system up and operating. An OS is the best support system for critical systems. The model weighs a Mixed system as neutral.

SUPPORT SYSTEM DECISION MATRIX FOR LOGMARS

Factors		Support Method			
		NS	TCS	OS	MIX
Degree of Militarization	Low	0	+	0	0
Environment	Benign	0	+	0	0
Operating Cycle	Long	-	0	0	+
Application	Present	0	0	X	0
Criticality	Essential	-	-	+	0
Availability	High	+	0	0	0
Cost	High	-	0	+	+
Population	High	-	-	*	0
Complexity	Complex	0	+	-	+
Maintenance Level	I&D Level	-	+	0	+
SUMMARY:					
*		0	0	1	0
+		1	4	2	4
0		4	4	5	6
-		5	2	1	0
X		0	0	1	0
Score:		-4	2	1	4

Exhibit 1

2. System Specific Factors

a. System Availability

As noted in Chapter IV, LOGMARS enjoys high availability. The designer was able to employ many techniques to improve reliability of the system. Also, the system is operated in a benign environment and the equipment is normally protected from damage due to weather, improper handling and other forms of mistreatment. Ignoring all other factors, high system availability is best suited for a throw-away support system. But high availability does not detract from the other forms of support and these are weighted neutrally by the SSDM.

b. System Cost

System cost is the major factor that eliminates NS as a support system. Compared to major systems, such as aircraft or ships, LOGMARS may seem to be a relatively inexpensive system. However, in the context of warehousing costs, it represents a large capital expense, second only to the building and land. Also, the more expensive the system, the more it becomes cost-effective for the Navy to develop an organic capability for repair. This factor indicates that either a OS or a Mixed support system would be more beneficial.

c. System Population

System population for LOGMARS is high on a Navy-wide level, yet the number of equipment at each site is relatively low. The weighting of this factor shows the Navy should consider developing some organic support capability. This factor indicates TCS and NS are not favored.

d. System Complexity

This factor must be considered in the context of the equipment normally repaired and supported by warehouse personnel. Although LOGMARS is not a technically complicated system, it is very complex compared to other equipment in the warehouse. An OS system would require special training and tools for the support persons. Therefore, some support will be required from the contractor, either TCS or a Mixed system.

e. System Maintenance Concept

The System Maintenance Concept factor describes the level at which the majority of maintenance is performed. The majority of maintenance for LOGMARS is conducted at the intermediate and depot level. Alone, this factor indicates a requirement for a repair capability. It is also understood that the contractor can normally provide this level of maintenance at a lower cost then an organic system. This is due to the high cost of establishing training, equipment and supply support for the OS.

C. CONCLUSION

Analysis of the support decision for the LOGMARS system using the SSDM shows that a Mix of contractor and organic support is clearly favored over the other methods. The most significant factors are the benign environment, the long operating cycle, the high cost and large population. Total Contractor Support and Organic Support rank a distant second. The high cost and large population indicate that Organic Support would be cost effective and the complexity and benign environment favor Contractor support.

As discussed in Chapter IV, the relative weightings of the factors are equal. Therefore, the recommended alternative can be determined by simply adding the numbers of "+", "-", "0", "*", and "X" for each method. Another method that might be used is to determine which method is "dominate" over the other methods. This analysis involves comparing each method to the others by the factors to determine which is "dominate". For example, comparing TCS to NS, each factor is relatively more favorable in the TCS method over the NS method except for the Availability factor. In other words, comparing the methods factor by factor, TCS is equal or more favored to NS. For Degree of Militarization, Environment, and complexity TCS ranks "+" to "0" for NS. Each factor can be compared in turn to show that TCS dominates NS for all factors except availability.

Relative rankings of the model may be argued and choosing the category for each factor is subject to judgement. The point of the model is to first, demonstrate the many factors in the support decision. Second, many of these factors are interrelated and must be judged in the context of the specific application under consideration.

VI. CONCLUSIONS AND RECOMMENDATIONS

A. CONCLUSIONS

This thesis examined the logistic support concepts for Non-Developmental Items (NDIs). The research focused on how system use factors and system specific factors affect the decisions on how to support the system. The result of this research is the Support System Decision Model (SSDM) presented in Chapter IV. The goal of this thesis has been to serve as a basis for establishing Department of the Navy guidelines for NDI logistic support and to help decision makers in choosing a logistic support system best suited for their program. The conclusions that can be drawn from this study are listed below:

1. The NDI method of procurement has an important place in the Navy's acquisition programs.

2. The decision regarding the use of NDI is made early in the program.

3. The shortened acquisition cycle of NDI's adversely impacts that system's logistic support.

4. System use factors and system specific factors are the best indicators of which support system to choose foı an NDI.

5. The decision makers must choose the support system as early as possible in the acquisition program.

1. NDI's Important Role

The NDI method of procurement has an important place in the Navy's acquisition programs. The effect of using NDI in the acquisition varies from case to case. In each case, NDI offers some advantages and some disadvantages over a normal development program. The benefits attributed to NDI include lower costs, shorter acquisition cycles and speeding current technology to the field. NDI also poses some problems to the acquisition cycle. Every procurement is different and each situation must be studied to find how NDI can help the program.

2. Choose NDI Strategy Early

The decision regarding using NDI is made early in the program. An NDI strategy is the only way to meet some requirements. In this case, the acquisition manager will concentrate on finding the best commercial market solution to meet the mission need. Even when the program manager is not directed to use an NDI solution, it is among the alternatives that are continuously reviewed during system development.

3. NDI's Detriment to Logistics

The most significant drawback of using an NDI to meet a mission need is the detrimental impact to the logistic support system created by the lack of program time to evaluate requirements. NDI programs are special because they shorten the acquisition cycle. Selection of commercial items also reduces the interval between production award and initial delivery of the entire system to the user. Under the accelerated conditions of an NDI program, the time required to prepare, staff, and approve program management documents, manpower authorizations, and the time required for establishing a logistic support system is often greater than the time required to produce and deliver the hardware.

4. System Use and System Specific Factors

In deciding the proper logistic support system for an NDI, the best indicators are a combination of system use factors and system specific factors. By focusing on these factors, decision makers can use the heuristic model in Chapter V to rank the alternative forms of supporting their system.

5. Early Decision

Finally, as in many other program decisions, the choice of a logistic support method must be made as early as possible in the program. As already mentioned, NDI programs lack the time for a detailed logistic support analysis and the program manager must rely on the research and development information gathered by the commercial developer. Delaying the support decision compounds the problem of having the support system in place for the Initial Operating Capability (IOC) of the system.

B. RECOMMENDATIONS

As a result of this research, the following recommendations are presented:

1. Continue to emphasize the use of NDI as a primary acquisition strategy.
2. Ensure that NDI systems are held to the same standards for quality of logistic support when being fielded.
3. Defense Systems Management College (DSMC) should complete the effort on the NDI Handbook.

1. NDI as an Acquisition Strategy

Many instructions regarding acquisition require decision makers to consider NDI as part of the acquisition strategy. This requirement must continue to be emphasized for all levels of the Department of Defense (DOD). Of course the acquisition strategy must reflect the complexity and scope of the program, but every effort must be made to fully exploit the available commercial solutions to military requirements. DOD cannot duplicate the efficiency of the free market in designing solutions to its problems. However, program managers at all levels should only begin a full scale development program when it has been satisfactorily determined that the commercial market cannot meet the needs of the requirement.

2. Equal Standards of Quality

Logistic support is a critical part of the effectiveness of every program. The legitimate desire of decision makers to field systems as soon as possible rushes the development of a logistic support system. This problem is especially profound in an NDI procurement. Yet logistic support requirements must receive the same consideration given to performance requirements and delivery schedules by program managers. The fact that an NDI procurement strategy allows a system to be fielded faster or more cheaply must not be used as justification for fielding a system without a support system.

3. Finish the NDI Handbook

The 1986 Packard Commission Report increased the emphasis on NDI procurement for all levels of DOD. The initial draft provides a wealth of information on the DOD's acquisition policy on NDI's. The manual defines NDI, explains how NDI acquisition can be tailored within the systems acquisition process and lists factors to consider when developing an NDI acquisition strategy. The responsible offices should complete the preparation of this manual and distribute it as widely among acquisition persons as is possible.

C. AREAS FOR FURTHER STUDY

The following issues were raised during the research and are recommended for further study:

1. Are special or abbreviated rules for acquisition of commercial products justified?

2. Do NDI's have a special ability to take advantage of competitive market forces?

3. What are the risks and effects of "end item proliferation" as a result of emphasis on NDI acquisition strategy?

1. Special Rules

Many documentation and analysis requirements in the DOD's acquisition program do not apply to products the are already developed. For example, Human Factors Analysis will not affect a system that is already being produced. These requirements are costly and add little to the quality of the system. There is significant room for elimination of requirements for commercial products. A study would focus on the need for a special set of acquisition regulations for buying commercial equipment.

2. NDI in the Competitive Market

Recent studies have indicated that the artificial competition created by establishing a second source for major defense systems may not provide any of the benefits of a natural competitive market. Conversely, NDI's have some unique characteristics to take advantage of competitive market forces. Research should focus on how NDI programs are effected by competition and how multiple sources benefit the Government.

3. End Item Proliferation

Many programs exist in DOD to protect against the effects of end item proliferation. These programs include the DOD Parts Control Program, the DOD Interchangeability and Substitutability System and the Defense Standardization and Specification Program. The effects of this proliferation on military readiness is not understood. Since the cataloging systems designed to minimize proliferation are dependent on technical data, the research would compare the support items for the NDI versus the non-NDI system.

APPENDIX A

NDI QUESTIONNAIRE

1. What is your activity's definition of a commercial/non developmental item (NDI) system?

2. How does the NDI acquisition differ from an acquisition on a system with a full development?

3. Was an NDI solution to the acquisition process mandated or was it reached as a result of the acquisition process?

4. At what point in the acquisition process, if any, was an NDI solution considered?

5. What were the major advantages gained by using the NDI?

6. What were the costs involved in using the NDI?

7. What do you see as the major impact of NDI on logistical support?

8. How can logistic support for NDI systems be improved?

9. What support system is best suited for supporting the NDI, organic, commercial, a mix, or no support at all?

10. What program characteristics affect how the system will be supported?

11. What system use characteristics affect how the system will be supported?

12. What system characteristics affect how the system will be supported?

APPENDIX B

GLOSSARY

Affordability

Affordability is the degree to which the system's costs can be borne by the procuring activity.

Availability

Availability is the measure of the degree a system is in the operable and committable state at the start of a mission when the mission is called for at an unknown, random time. This is often called "operational readiness." It is the probability that the system is operating satisfactorily at any point in time when used under stated conditions, where the total time considered includes operating time, active repair time, administrative time and logistics time.

Depot Maintenance

Depot maintenance is performed by designated maintenance activities on segmented stocks of serviceable material. Depot maintenance support, organizational maintenance, and intermediate maintenance activities are accomplished by the use of the more extensive shop facilities, equipment, and personnel of higher technical skill than are available at the lower levels of maintenance. Its phases normally consist of inspection, test, repair, modification, alteration, modernization, and overhaul of weapons systems and parts. Depot maintenance is normally accomplished in fixed ships, shipyards, and other shore-based facilities, or by depot field teams.

Integrated Logistic Support

Integrated Logistic Support (ILS) is a management function that provides the initial planning, funding and controls which help to assure that the ultimate consumer or user will receive a system that will not only meet performance requirements, but one that can be expeditiously and economically supported throughout its programmed life cycle. A major objective of ILS is to assure the integration of the various elements of support. Included within ILS is the development of a preliminary logistic support plan during the conceptual design phase and a formal integrated logistic support plan (ILSP) during the advanced development phase.

Intermediate Maintenance

Intermediate maintenance is the responsibility of and is performed by designated maintenance activities for support of using organizations. Its phases normally consist of calibration, and repair or replacement of damaged or unserviceable parts, components, or assemblies; the manufacture of critical non-available parts; and providing technical assistance to using organizations. Intermediate maintenance is normally accomplished in fixed or mobile ships, tenders, shore-based repair facilities, or by mobile teams.

Life Cycle Cost

Life Cycle Cost (LCC) involves all costs associated with the system life cycle, to include:

1. Research and development (R&D) cost - the cost of feasibility studies; system analyses; detail design and development, fabrication, assembly, and test of engineering models; initial system test and evaluation; and associated documentation.
2. Production and construction cost - the cost of fabrication, assembly, and test of operational systems (production models); operation and maintenance of the production capability; and associated initial logistic support requirements.
3. Operation and maintenance cost - the cost of sustaining operation, personnel and maintenance support, spare and repair parts and related inventory costs, test and support equipment maintenance, transportation and handling, facilities, modifications and technical data changes.
4. System retirement and phaseout cost - the cost of phasing the system out of the inventory due to obsolenscence or wearout, and subsequent equipment item recycling and reclamation as appropriate.

Logistic Support Analysis

Logistic Support Analysis (LSA) is an iterative analytical process by which the logistic support necessary for a new system is identified and evaluated. LSA constitutes the application of selected quantitative methods to (1) aid in the initial determination and establishment of logistic criteria as an input to system design, (2) aid in the evaluation of various design alternatives, (3) aid in the identification and provisioning of logistic support elements, and (4) aid in the final assessment of the system support capability during consumer use. LSA is a design analysis tool employed throughout the early phases of system development and often includes the maintenance analysis, life cycle cost analysis, and logistics modeling. An output of LSA is the identification of and justification for logistic support resources. This output is sometimes identified as the logistic support analysis record (LSAR.)

Maintainability

Maintainability, like reliability, is an inherent characteristic of system design. It pertains to the ease, accuracy, safety, and economy in the performance of maintenance actions. A system should be designed such that it can be maintained without large investments of time, cost, or other resources (e.g., personnel, materials, facilities, test equipment) and without adversely affecting the mission of that system. Maintainability is the ability of an item to be maintained, whereas maintenance constitutes a series of actions to be taken to restore or retain an item in an effective operational state. Maintainability is a result of design.

Maintainability can also be defined as a characteristic in design that can be expressed in terms of maintenance frequency factors, maintenance times, and maintenance cost. These terms may be presented as different figures of merit; therefore, maintainability may be defined on the basis of a combination of factors, such as:

1. A characteristic of design and installation which is expressed as the probability that an item will be retained in or restored to a specified condition within a given period of time, when maintenance is performed in accordance with prescribed procedures and resources
2. A characteristic of design and installation which is expressed as the probability that maintenance will not be required more than x times in a given period, when the system is operated in accordance with prescribed procedures. This may be analogous to reliability when the latter deals with the overall frequency of maintenance.
3. A characteristic of design and installation which is expressed as the probability that the system is maintained in accordance with prescribed procedures.

Maintainability requires the consideration of many different factors involving all aspects of the system. Maintainability is an inherent characteristic of design, must be properly considered in the early phases of system development, and maintainability activities are applicable throughout the life cycle.

Organizational Maintenance

Organizational maintenance is the responsibility of and is performed by a using organization on its assigned equipment. Its phases normally consist of inspecting, servicing, lubricating, adjusting, and the replacement of parts, minor assemblies, and subassemblies.

Reliability

Reliability is the probability that a system or product will perform in a satisfactory manner for a given time when used under the specified operating conditions. This definition stresses the elements of probability, satisfactory performance, time and specified operating conditions. These four elements are extremely important, since each plays a significant role in determining system reliability.

Probability, the first element in the reliability definition, is usually stated as a quantitative expression representing a fraction or a percent signifying the number of times that an event occurs (successes), divided by the total number of trials. For instance, a statement that the probability of survival of an item for 80 hours is 0.75

(or 75%) indicates that we can expect that the item will function properly for at least 80 hours, 75 times out of 100 trials.

When there are a number of supposedly identical items operating under similar conditions, it can be expected that failures will occur at different points in time; thus, failures are described in probabilistic terms. In essence, the fundamental definition of reliability is heavily dependent on the concepts derived from probability theory.

Satisfactory performance, the second element in the reliability definition, indicates that specific criteria must be established which describes what is considered to be satisfactory system operation. A combination of qualitative and quantitative factors defining the functions that the system or product is to accomplish, usually presented in the context of a system specification, are required.

The third element, time, is one of the most important since it represents a measure against which the degree of system performance can be related. One must know the "time" parameter in order to assess the probability of completing a mission or a given function as scheduled. Of particular interest is being able to predict the probability of an item surviving (without failing) for a designated period. Also, reliability is frequently defined in terms of mean time between failure (MTBF), mean time to failure (MTTF), or mean time between maintenance (MTBM); thus the aspect of time is critical in reliability measurement.

The specified operating conditions under which we expect a system or product to function constitute the fourth significant element of the basic reliability definition. These conditions include environmental factors such as geographical location where the system is expected to operate, the operational profile, the transportation profile, temperature cycles, humidity, vibration, shock, and so on. Such factors must not only address the conditions for the period when the system or product is operating, but the conditions for the periods when the system (or a portion thereof) is in a storage mode or being transported from one location to the next. Experience has indicated that the transportation, handling, and storage modes are sometimes more critical from a reliability standpoint than the conditions experienced during actual system operational use.

The four elements discussed above are critical in determining the reliability of a system. System reliability is a key factor in the frequency of maintenance, and the maintenance frequency obviously has a significant impact on logistic support requirements. Reliability predictions and analyses are required as an input to the logistic support analysis.

Reliability is an inherent characteristic of design. As such, it is essential that reliability be adequately considered at program inception, and that reliability be addressed throughout the system life cycle.

Supportability

Supportability relates to the degree to which the system can be supported, both in terms of the inherent characteristics of prime equipment design and the effectiveness of the overall support capability (i.e., elements of logistic support.) This term is commonly used in a rather general sense, and its use often implies some degree of overlap with reliability and maintainability.

APPENDIX C

ACRONYMS

ATE	Automatic Test Equipment
CD&V	Concept Demonstration and Validation
CECOM	Communications-Electronics Command
CE/D	Concept Exploration/Definition
DCP	Decision Coordinating Paper
DOD	Department of Defense
DODD	Department of Defense Directive
DOP	Decision Options Paper
F^3	Form, Fit and Function
FSD	Full Scale Development
ILS	Integrated Logistic Support
ILSP	Integrated Logistic Support Plan
IOC	Initial Operating Capability
LCC	Life Cycle Costs
LCDR	Lieutenant Commander
LOGMARS	Logistic Applications of Automated Marking and Reading Symbols
LSA	Logistic Support Analysis
MAA	Mission Area Analysis

MILSPEC	Military Specification
MILSTD	Military Standard
MLDT	Mean Logistics Delay Time
MNS	Mission Need Statement
MTBF	Mean Time Between Failure
MTTR	Mean Time To Repair
NAVSUP	Naval Supply Systems Command
NDI	Non Developmental Item
NS	No Support
OMB	Office of Management and Budget
OPNAV	Office of the Chief of Naval Operations
OR	Operational Requirement
OS	Organic Support
OT&E	Operational Test and Evaluation
POM	Program Objectives Memorandum
PMO	Program Management Office
PPBS	Planning, Programming and Budgeting System
RAM	Reliability, Availability, Maintainability
ROC	Required Operational Capability
R&D	Research and Development
SCP	System Concept Paper
SPAWAR	Space and Warfare Systems Command
SSDM	Support System Decision Matrix

TCS	Total Contractor Support
TEMP	Test and Evaluation Master Plan
TOR	Tentative Operational Requirement
WSA	Weapon System Architecture
WSE	Weapon System Engineering

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